The Impact of Business Process Complexity on Business Process Standardization

An Empirical Study

We test a model which explains the triangle between business process complexity, business process standardization and standardization effort. We use data collected from an online survey among 255 BPM experts, applying reliable and validated measurement scales for each of our constructs. The model provides significant results in order to explain the relationships between our three constructs. The analysis generates several findings. First, business process complexity has a significant and positive impact on standardization effort. Furthermore, our data show a negative and significant relationship between business process complexity and business process standardization. Surprisingly, our data do not support the assumed positive relationship between standardization effort and business process standardization.

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1 Introduction

Business process improvement continues to be on the agenda of top management worldwide (GartnerGroup 2010; Luftman and Zadeh 2011). It is generally accepted that business process management (BPM) can significantly improve an organization's performance (Kettinger and Teng 1997; Reijers and Liman Mansar 2005). Business process standardization is an often discussed approach to increase business process performance (Davenport 2005; Hammer and Stanton 1999) and refers to using standard parts and standard operating procedures for process activities, both of which remove operator discretion, ambiguity, and opportunities for making mistakes (Anupindi et al. 2006, p. 274). The standardization of business processes enables organizations to decrease flow times, lower inventories, and achieve higher throughput (Anupindi et al. 2006, p. 276). Often-mentioned benefits include cost savings and an increase in profits due to higher efficiency, decreasing risks, and improved transparency, controllability, and quality (Muenstermann et al. 2010; Ramakumar and Cooper 2004; Thawani 2004; Wüllenweber et al. 2008).

The design and implementation of standardized business processes often requires substantial standardization efforts in terms of time, money, and other resources (Mutschler and Reichert 2012). Furthermore, organizations are struggling with increasing complexity of business processes due to a proliferating variety of elements and interconnections within business relationships, such as customer-tailored products or services, global procurement and distribution, and a higher number of value chain partners (Blecker et al. 2005). Business process complexity is defined in terms of low levels of analyzability, high levels of variety (Mani et al. 2010, p. 42), and high levels of non-routineness, difficulty, uncertainty, and interdependence of a business process (Karimi et al. 2007, p. 207). High business process complexity renders it difficult to establish rules, standard operating procedures, and responses to potential problems (Daft and Macintosh 1981; Mani et al. 2010). With rising business process complexity, it becomes harder and more expensive to standardize business processes (Rosenkranz et al. 2010), and it is almost impossible to predefine all possible workflows.

Moreover, studies on business process standardization so far mostly focus on manufacturing industries, where the predominant process structures are highly repetitive assembly lines with rigid, fixed parts and routes (Anupindi et al. 2006, p. 26). However, today's value creation is more and more dominated by services, which are characterized by a diversity of unique and customer-focused processes (Spohrer and Maglio 2010). Although business process standardization offers convincing benefits, having diversity in business processes allows different kinds of customers to be served in different ways; "In a process enterprise, the key structural issue is no longer centralization versus decentralization – it's process standardization versus process diversity" (Hammer and Stanton 1999, p. 114).

Due to these challenges, business process standardization is an important research area, calling for more research on the characteristics of business processes (Venkatesh 2006, p. 497). An integrated and systematic understanding of process characteristics, other underlying factors, and their effects on business process standardization is needed. In this paper, we ask how business process complexity and business process standardization are related with respect to standardization efforts because we think that the characteristics of a business process form its complexity. We develop and present a research model that focuses on the relationship between standardization effort, business process complexity, and business process standardization. We focus on the business process itself as the unit of analysis and address a set of process-inherent characteristics.

The remainder of the paper is structured as follows. We first discuss related work and the theoretical background of our research. Following this, we outline our research model. Afterwards, we describe and discuss our empirical study. We use a survey-based questionnaire to collect data and test our model using structural equation modeling. We analyze our data, present our findings, and discuss the results and contributions of our research. Finally, we give directions for further research.

2 Related Work and Theoretical Background

2.1 Business Process Standardization and Standardization Effort

A business process is generally understood as a sequence of actions, carried out by actors or information technology (IT), by which organizations transform inputs into outputs (Lillrank 2003, p. 219; Pentland 2003b, p. 529). Business processes cut horizontally across the organization and create an interrelated organizational subsystem that forms a micro-structure of related tasks, technology, and people (Kettinger and Grover 1995, p. 12). Therefore, business processes cover a wide range of activities within an organization. The spectrum ranges from iterative and simple to creative, or knowledge-intensive, and unique business processes (Anupindi et al. 2006, pp. 26–33).

BPM includes methods, techniques, and tools to support the design, enactment, management, and analysis of operational business processes (van der Aalst et al. 2003). Business process standardization as an instrument of BPM is defined as the unification of business processes and the underlying actions within an organization in order to "facilitate communications about how the business operates, to enable handoffs across process boundaries in terms of information, and to improve collaboration and develop comparative measures of process performance" (Davenport 2005, p. 102). The objective is to specify transparent and uniform process activities across the organization or value chain (Wüllenweber et al. 2008, p. 213) to create a time-, cost-, and quality-optimal way of achieving the business processes' goal (Muenstermann et al. 2010, p. 30).

The main challenge during standardization initiatives is to turn existing process variants into standard operating procedures that are obligatory to all actors in an organization (Lillrank and Liukko 2004, p. 41). This is an organizational effort directed towards standardizing appropriate business processes. Business process models or diagrams are often used to create and document unified specifications within such initiatives (Moody 2005). Afterwards, IT can be implemented that supports the execution of standardized processes, for example, through ERP systems that eliminate transport and waiting times between process activities (Karimi et al. 2007), or workflow management systems that provide a detailed level of control over the assignment of work given to process participants (zur Muehlen 2004). Viewed from a BPM perspective, standardization effort is defined as the sum of the resources spent (e.g., time, people, or money) in order to standardize a business process within an organization (Lee and Tang 1997; Mutschler and Reichert 2012). Relating standardization effort to the likelihood of business process standardization, given specific sources of and specific levels of process variability, we expect that the more resources we invest in standardization, the more standardization we will achieve (Anupindi et al. 2006, p. 274):

H1: *Standardization effort is positively associated with business process standardization.*

Many factors on differing levels of analysis may affect both standardization effort and business process standardization or their relationship (Kettinger and Grover 1995; Kettinger et al. 1997). For example, amongst others, possible contextual factors on the organizational level are the extent of business process standardization (e.g., functional, organizational, or geographic scope, Karimi et al. 2007), the means by which the standardization initiative is supported and managed (e.g., top management support, training resources, or project management resources; Baldwin et al. 2001; Karimi et al. 2007), or the organizational culture (e.g., basic assumptions and beliefs or values, Schein 1985). Possible factors on the individual level are resistance to knowledge transfer (Empson 2001) or resistance to change (Aladwani 2001). In addition, various factors on the environmental level may have an impact (e.g., economic conditions, industry competitiveness, political and legal factors; Kettinger and Grover 1995).

While these factors are all important, we focus on the process level, particularly the process-inherent characteristics that determine the complexity of a business process. Factors on the process level are intrinsic to the business process itself, whereas the other contextual factors named above impact on the business process, on its standardization, and on standardization effort.

2.2 Business Process Complexity

A business process needs a specific level of complexity to be able to cope with the complexity of its environment (e.g., Flood and Carson 1993, p. 23; Jackson 2000, p. 73; Tushman and Nadler 1978). Business process complexity is related to the difficulty, uncertainty, and interdependence associated with the activities of a business process (Karimi et al. 2007, pp. 107–108). Complex business processes have high task variety and low analyzability (Mani et al. 2010; Niranjan et al. 2007). With increasing complexity, more information must be processed in order to monitor and assure the quality of business processes (Fredendall et al. 2009, p. 330; Melville and Ramirez 2008, pp. 263–264). If process activities are uncertain and highly interdependent, this will increase the complexity of the business process. This means that process managers or operators will be confronted with high uncertainty, high variety, and interdependence of the process activities (Karimi et al. 2007; Mani et al. 2010; Niranjan et al. 2007).

Business process complexity undermines standardization aims and causes wasted effort (Barki and Pinsonneault 2005, p. 165; Hall and Johnson 2009, p. 60; Hanseth et al. 2006, p. 563; Mani et al. 2010, p. 41; Sobek et al. 1998, pp. 44–46). A business process with a low level of business process complexity will be standardized with low standardization effort, while a business process with a high level might require high standardization effort. The more complex a business process is, the higher the needed effort will be. Therefore, we state:

H2: *Business process complexity is positively associated with standardization effort.*

Moreover, business process complexity has a major effect on business process standardization. The nature and characteristics of an individual business process allow assigning it to one of the three types proposed by Lillrank (2003): standard, routine, and non-routine (**Table 1**). The main difference between the types is that each of them belongs to another level of business process complexity: a standard process represents the lowest level of complexity, whereas a non-routine process exhibits the highest level.

A standard process exhibits predetermined input, produces an ex-ante specified output, and is repeated identically. Its content variety is determined (Lillrank 2003, p. 223), which means that every activity can be processed each time in an optimal way. A routine process can have more variety in the work activities, and two or more types of alternative outputs (Lillrank 2003, p. 223; Mason 1978, p. 220). The input of a routine process must be interpreted and classified before a finite set of actions and algorithms can be selected (Lillrank 2003, pp. 222–225; Lillrank and Liukko 2004, p. 41). The goal is usually clear, but can be achieved through different actions because of the variety in the sequence of events or actions (Pentland 2003a, pp. 857–861). A non-routine process is characterized by a vague or unknown set of inputs and outputs (Lillrank and Liukko 2004, p. 42). The unknown input cannot be directly linked to specific actions or algorithms. The input set's variety is larger than the experience set employed by the process (Lillrank 2003, p. 224). This uncertainty of inputs may only be dealt with by highly skilled or experienced employees (experts) who develop new knowledge and heuristics while executing the process.

Table 1 Characteristics of standard, routine, and non-routine processes (Lillrank 2003)

	Standard	Routine	Non-routine
Acceptance criteria	Single variety	Bounded variety set	Open input set
Assessment	Acceptance test	Classification	Interpretation
Conversion rules	Switch, algorithm	Algorithm, grammar, habit	Heuristics
Repetition	Identical	Similar but not identical	Non-repetitive
Logic	Binary	Fuzzy	Interpretative

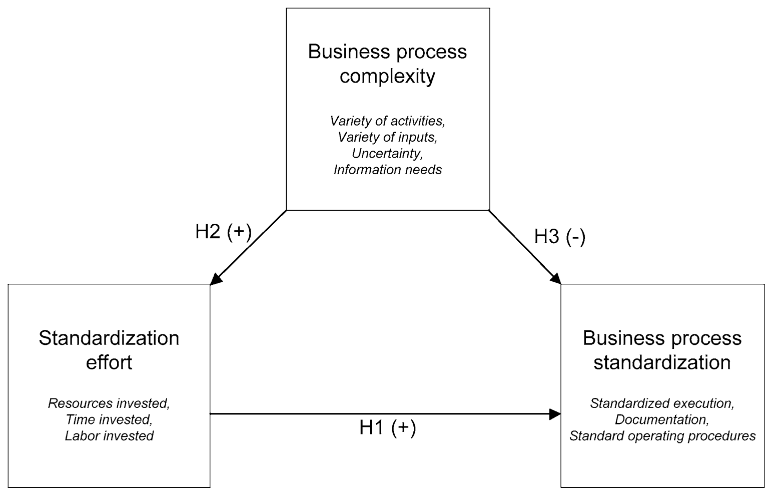

Fig. 1 Research model

Standardization may therefore not be feasible if the environmental complexity faced by the business process is high and cannot be reduced; then the business process needs to mirror this high environmental complexity, which contradicts standardization (Lillrank 2003, p. 225). Referring to Lillrank's (2003) classification, we conclude that the higher the complexity of a given business process, the lower the resulting standardization. Therefore, we propose:

H3: *Business process complexity is negatively associated with business process standardization.*

2.3 Research Model

Our research model in **Fig. 1** summarizes the previously discussed concepts and their relationships. H1 posits a positive relationship between standardization effort and business process standardization. In combination with H2 (positive effect between business process complexity and standardization effort) and H3 (negative effect between business process complexity and business process standardization), this leads to a model which can be summarized as follows: the negative relationship between business process complexity and business process standardization is mediated by standardization effort.

3 Research Study

3.1 Measurement

We operationalized all latent variables as reflective indicators because we are primarily interested in testing a theoretical model (Bollen and Lennox 1991, p. 306). All constructs are modeled as first order constructs and measured using at least three items on 7-point Likert-type scales, ranging from "strongly agree" to "strongly disagree". (The final set of items for the operationalization of our constructs is presented in Appendix A; the complete questionnaire is included in Appendix C.) We developed and pretested initial measurement scales for every construct with 35 BPM experts in order to ensure content validity of our measures (cf. Schäfermeyer and Rosenkranz 2011 for details). We followed established guidelines (Moore and Benbasat 1991) and used semi-structured interviews to ensure content validities as well as an item-sort task to assess the measures' substantive validities in order to predict the measures' performance (Anderson and Gerbing 1991). Due to the fact that we used self-reported measures within our survey, we also tested our data for a common method bias (Podsakoff et al. 2003). The test suggests that it is unlikely that method bias has significantly affected the study results (Appendix B).

For business process standardization, we adopt three items from previous research on the relationship between business process standardization and business process performance by Muenstermann et al. (2010) and ask survey participants to rate how well-documented, regulated, and standardized the process is. Due to the fact that Muenstermann et al. (2010) had a special focus on staff recruitment processes within their study, we modified the original items in order to give them a wider scope. The main intention here is to make the items usable to measure the standardization of any process within any organization.

The measurement of standardization effort is more problematic because no generally accepted instrument for effort assessment exists (Green and McIntosh 2001, pp. 292–293). We measure standardization effort by taking into account the subjective effort deployed by process managers. We adopt measures by Brown et al. (1997) and ask survey participants to rate how much time, work intensity, and overall effort they put into their standardization. We rearranged the wording in order to make the items capable of measuring the invested standardization effort of process managers. Of course, measuring standardization effort with not only psychometric measures would be ideal, for example, by using the actual full-time equivalents that were spent (e.g., in staff hours, days, or months). Unfortunately, such data was not available to us. Simply asking survey participants how many staff hours were spent for standardization without cross-checking against documented data would not enhance the measures. Furthermore, we focus on effort invested for what Davenport (2005, p. 101) defines as intra-company process standardization. Intra-company standardization intends to improve the performance and business operations within a specific company. It has to be separated from inter-company process standardization where process standardization is performed across companies.

For business process complexity, the inherent characteristics of standard, routine, and non-routine processes (**Table 1**) provide first indicators that offer a suitable basis for measures of complexity. Based on this, business process complexity is a function of the number and variety of all activities forming the business process, their interrelations, and dynamics (Karimi et al. 2007; Lillrank 2003; Mani et al. 2010). We operationalize business process complexity as a measure for the self-reported difficulty faced by process managers and operators, during process standardization or execution, which is caused by process-inherent characteristics such as the degree of non-routineness, variety, and uncertainty.

3.2 Sample and Data Collection

In order to test our research model, we collected empirical data by means of a survey-based questionnaire among BPM experts. We collected the data via a web-based instrument. The targeted population for this study was experts with long-time experience in BPM and the accomplishment of standardization initiatives. BPM experts world-wide were invited to participate in the online survey through advertisements made on online forums and social networks (e.g., XING, LinkedIn, or local BPM groups).

At the beginning of our survey, respondents were instructed to define and explain a reference process which fulfills three conditions: first, the reference process is a core production or service process within the respondent's organization. Second, the respondent is an expert in that process and, third, the expert ideally was/is involved in its successful standardization or its standardization attempt. Respondents were then instructed to refer specifically to this process in their subsequent responses. Concerning a potential selection bias, the first condition (core process) ensures that processes are chosen that are important for the organization's value creation. The second condition (respondent is an expert) ensures that respondents know what they are talking about and have sufficient expert knowledge to judge on details of the intended process. The third condition (involvement in standardization attempt) enables us to account for processes independent of the success of standardization attempts and avoids just telling "success stories", which is of critical importance for our study.

From February to March 2011, we obtained 575 responses from which 255 were usable after list-wise deletion of missing data. Descriptive statistics about the organizational and personal demographics of the respondent population are summarized in **Tables 2** and **3**. 69 % of the respondents have had at least five years or more BPM experience and therefore are classified as qualified BPM experts.

We subsequently used the aspects "Sector", "Investments in BPM per year", "Job position", and "BPM experience in years" as control variables to account for the differences among organizations and BPM experts respectively. We selected those four contextual variables because of their potential impact on business process standardization (cf. Sect. 2.1).

4 Data Analysis and Results

4.1 Descriptive Statistics and Measurement Properties

We transferred our research model (**Fig. 1**) into a structural equation model (SEM) and estimated our model using the maximum-likelihood algorithm. Within our data set, skewness values ranged from −1.624 to −0.122 and kurtosis values from −0.871 to 2.887. As all indicators fall into the recommended range (skewness < 2; kurtosis < 7) (Curran et al. 1996, p. 26), we tested our measurement scales for reliability and validity. **Table 4** summarizes the descriptive statistics for all three observed variables: business process standardization (BPS), standardization effort (SE), and business process complexity (BPC).

Table 2 Organizational characteristics

Aspect	Values	# of responses	Percentage
Sector	Service sector	213	0.84
	Production sector	42	0.16
No. of employees	<250	97	0.38
	250–1000	35	0.14
	>1000	123	0.48
Size of BPM department or division (no. of employees)	<10	118	0.46
	10–30	62	0.24
	>30	75	0.29
Investment in BPM per year	<100,000 EUR	151	0.59
	100,000–500,000 EUR	55	0.22
	>500,000 EUR	49	0.19

Table 3 Participant demographics

Aspect	Values	# of responses	Percentage
Job position	Process consultant	49	0.19
	Project leader	92	0.36
	Senior manager	49	0.19
	Director	36	0.14
	CIO/CEO	29	0.11
BPM experience in years	<2	32	0.13
	2–4	47	0.18
	5–10	100	0.39
	>10	76	0.30

4.2 Measurement Model Testing

The validity of the measurement scales was assessed via confirmatory factor analysis (CFA) calculated with SPSS/AMOS (Version 19). We modeled all scale items as reflective indicators of their hypothesized latent constructs and allowed all constructs to covary in the CFA model. We examined the measurement model with the following procedure that consists of four steps and tests respectively.

First, we checked Cronbach's alpha in order to assess whether the items are unidimensional and reliable (Nunnally and Bernstein 1994, pp. 233–236). All constructs reach alpha values above 0.8 (between 0.865 and 0.928 in **Table 5**) and meet the criteria for unidimensionality. Second, scale values for composite reliability (between 0.868 and 0.933 in **Table 5**) all passed the required cut-off values of 0.5 and therefore are considered as reliable (Jöreskog et al. 2001).

Third, we tested for convergent validity (Fornell and Larcker 1981, p. 46). All factor loadings were significant ($p = 0.000$) and lie above the recommended threshold of 0.6 within a range from 0.653 to 0.963 (**Table 4**). As already stated, values for composite reliability (**Table 5**) all top the threshold of 0.8 and all AVE-values (between 0.598 and 0.824) pass the 0.5 threshold. Therefore convergent validity is achieved. Furthermore, we checked the cross-loadings in order to identify if the items are measuring other constructs than hypothesized. All items reached the highest loadings with their intended constructs (**Table 4**).

Table 4 Descriptive statistics, factor loadings, and cross-loadings

Construct	Item	*N*	Min, Max	*M* (SD)	Skewness	Kurtosis	BPS	SE	BPC
BPS	BPS1	255	1, 7	3.94 (1.60)	−0.122	−0.871	**0.774**	−0.162	−0.269
	BPS2	255	1, 7	4.59 (1.64)	−0.445	−0.793	**0.797**	−0.167	−0.276
	BPS3	255	1, 7	4.44 (1.59)	−0.415	−0.519	**0.910**	−0.191	−0.316
SE	SE1	255	1, 7	4.87 (1.49)	−0.558	−0.249	−0.165	**0.789**	0.500
	SE2	255	1, 7	5.03 (1.53)	−0.769	−0.043	−0.201	**0.960**	0.608
	SE3	255	1, 7	5.11 (1.46)	−0.818	0.176	−0.202	**0.963**	0.610
BPC	BPC1	255	1, 7	5.37 (1.49)	−0.997	0.609	−0.288	0.526	**0.830**
	BPC2	255	1, 7	5.3 (1.59)	−0.970	0.343	−0.227	0.414	**0.653**
	BPC3	255	1, 7	5.03 (1.54)	−0.672	−0.153	−0.231	0.422	**0.666**
	BPC4	255	1, 7	5.41 (1.51)	−1.022	0.624	−0.297	0.542	**0.856**
	BPC5	255	1, 7	5.78 (1.37)	−1.624	2.887	−0.290	0.529	**0.835**

M = Mean, SD = Standard Deviation

Table 5 Scale properties and inter-construct correlations

Construct	Cronbach's alpha	Composite reliability	AVE	BPS	SE	BPC
BPS	0.865	0.868	0.687	0.687		
SE	0.928	0.933	0.824	0.044	0.824	
BPC	0.877	0.879	0.598	0.12	0.401	0.598

Table 6 Goodness of fit statistics

Fit index	Suggested value	Research model results
$\chi 2\ (df, p)$	–	82.556 (41, 0.00)
$\chi 2/df$	<3	2.014
RMSEA	<0.080	0.075
SRMR	<0.080	0.061
AGFI	>0.850	0.881
GFI	>0.900	0.926
NFI	>0.900	0.941
TLI	>0.950	0.959
CFI	>0.950	0.969

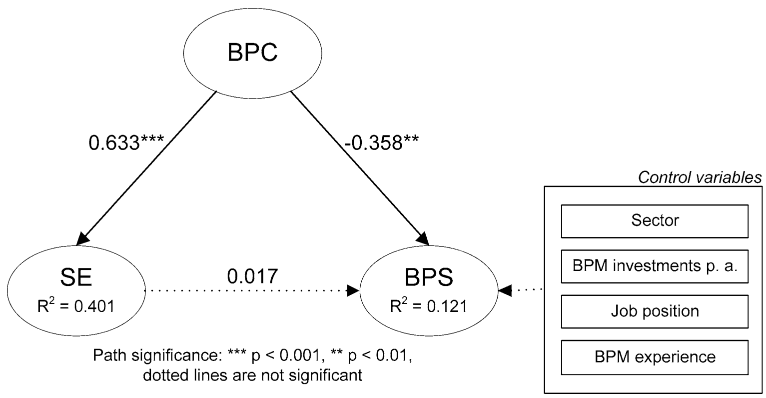

Fig. 2 Model results

Finally, we assessed discriminant validity. The highest squared correlation between any pair of constructs is 0.401 and the smallest AVE is 0.598. These results satisfy the criteria for discriminant validity (Fornell and Larcker 1981, p. 41).

4.3 Structural Model Testing

We examined the fit of the structural equation model as well as the significances and effect sizes (β) for each hypothesized path and variance explained (R^2) for each dependent variable within the model. The data analysis was conducted by structural equation modeling with AMOS (Version 19). The theoretical constructs were linked as hypothesized in **Fig. 1**. The SEM results are shown in **Fig. 2**.

Our research model is able to explain 12.1 % of the variance in business process standardization (BPS) and 40.1 % in the variance of standardization effort (SE). The goodness of fit indices in **Table 6** indicate an overall good fit of our hypothesized model to the data set (Browne and Cudeck 1993; Carlson and Mulaik 1993; Homburg and Giering 1996; Hu and Bentler 1999). Concerning the hypothesized paths in the model, we ascertain that business process complexity is a highly significant predictor of standardization effort ($\beta = 0.633, p < 0.001$) and of business process standardization ($\beta = -0.358$, $p < 0.01$). The directionality (positive or negative) of both paths is also confirmed. The relationships as assumed in H2 and H3 are supported by our model. However, the relationship between standardization effort and business process standardization (H1) and therefore the mediating effect of standardization effort is not significant ($p > 0.05$). In our data set, standardization effort has no impact on business process standardization, which is contrary to our expectations and to H1.

4.4 Cross-check for Moderator Effect and Sample Bias

Contrary to our research model, we found no significant relationship between standardization effort and business process standardization (H1) and no mediating effect of business process complexity. We performed a cross-check and tested for a possible moderating interaction effect following Chin's et al. (2003) guidelines with our current data. Since even for a small interaction effect, the effect size (f^2) has to be at least 0.02 (Chin et al. 2003; Gefen et al. 2000) and the interaction effect in our actual data set was not significant with an effect size f^2 of 0.01, we also have to reject the alternative hypothesis of business process complexity being a negative moderator of the relationship between standardization effort and business process standardization.

Regarding sample bias, we have to emphasize that the inclusion of any of the four control variables does not change the results of our SEM. The presence of any control variable does not affect the path weights among the major constructs in both models.

5 Discussion

The most important and surprising finding of our analysis is that standardization effort does not affect business process standardization (rejection of H1). The hypothesized positive effect turned out to be not significant for our data set. Standardization effort also does not mediate the negative relationship between business process complexity and business process standardization, as variations in effort do not significantly account for variations in standardization. Furthermore, we also found no moderating effect of business process complexity for the relationship between effort and standardization. These findings are surprising because they are counterintuitive: the more resources we spend on standardization, the more standardized a business process should become; either more complexity should negatively affect this relationship or more effort should mediate the complexity's negative effects. This is not the case in our data. However, as we carefully pre-tested our items in order to prevent measurement errors, we used control variables to deal with sample bias, and tested our data set for common method bias; we believe we provide a sound theoretical model tested with reliable survey instruments and data. Our results certainly have several limitations. First, we only examined the relationship of our three main constructs and did not consider other contextual factors that may influence business process standardization and standardization effort. Moreover, we used only psychometric measures, which could be a source of error especially for the construct of standardization effort. Another potential bias may result out of the fact that we also allowed respondents to assess business processes whose standardization was only attempted.

In order to explain the missing causal relationship of H1, we conclude for our data set that very complex business processes simply cannot be standardized, regardless of the invested effort. Although we cannot test this proposition with our collected data, our argument is supported by the fact that our analysis shows a negative and significant relationship between business process complexity and business process standardization (H3 is supported). This indicates that if a business process becomes more complex, the less this business process can be standardized. Furthermore, business process complexity has a significant and positive impact on standardization effort (H2 is supported), which means that the higher the complexity of a business process, the higher the effort spent in a standardization attempt (that is not necessarily successful or results in a standardized process). Due to the limitations of our study, further research is needed to explore the relationship between standardization effort and business process standardization.

We conclude that a process classification as proposed by Lillrank (2003) (**Table 1**) can be useful to select process types where standardization efforts might lead to standardization success. Standard processes are predestined for being exactly defined and standardized (Lillrank 2003, pp. 222–223). However, they only offer this potential and may *not* be standardized yet. A routine process is inherently more complex than a standard process and shows some inherent uncertainties concerning the process execution (Lillrank 2003, p. 224). A non-routine process is so complex and diverse that employees for the most part have to apply tacit knowledge, which would be economically senseless to be explicated in the form of standard operating procedures or process documentation (Davenport and Prusak 1998, p. 70). The task of management is to turn not-yet-standardized standard processes into standardized standard processes, and to determine the best way of execution by using standard operating procedures. A standard process is only successfully standardized if it is executed each time in a predefined (optimal) way by processing the same activities, in the same order, and producing exactly the same previously specified output. In other words, a simple business process (standard) can be highly standardized with low standardization effort. With rising business process complexity (routine), more standardization effort is needed in order to cope with this complexity and the resulting business process standardization is not as high as in the case of simple business processes – a routine simply cannot be standardized completely. At a very high level of business process complexity (non-routine processes), the success of standardization efforts is questionable because the resulting standardization is low or even impossible and only produces enormous standardization effort.

So the rule of thumb that companies should standardize their processes as much as possible without interfering with their ability to meet diverse customers' needs (Hammer and Stanton 1999, p. 115) is accurate, although it is not necessarily helpful if an organization has many routine and non-routine processes. For practitioners and managers, examples of critical questions that need to be addressed in further research are: how to manage an organization that simultaneously operates standard, routine, and non-routine processes; or how to deal with the rather different approaches and organizational subcultures involved in these different types of processes (Lillrank 2003, p. 230). If a business process is non-routine, more documentation in the form of detailed business process diagrams, more modelers and designers, or more IT support to increase operational efficiency have no effect on the inherent complexity that is due to variety and uncertainty. There is no way to unify all the variants because their number is simply too high and their design too varied, diverse, and uncertain. These characteristics are process-inherent and not due to bad process design, human errors, or natural fluctuations and variability. Therefore, investments in standardization are not a good choice in any case. Each business process has its given complexity that determines if it can be standardized, and if it can be standardized, the appropriate amount of standardization effort that is needed to complete this. Therefore, standardization effort has to be understood as a result or a dependent. It is not a management lever that guarantees or enables standardization in each and every case. Process managers should be aware that investing more resources in standardization initiatives in order to standardize "unstandardizable", complex processes will not be successful.

Moreover, complex processes may often well be combinations of subprocesses that are standard, routine, or non-routine (Lillrank 2003, p. 225). For example, business processes that involve creativity are not simply either creative or noncreative, but often combine creative parts (i. e., "pockets of creativity" that cannot be standardized) as well as noncreative parts (i. e., that can be standardized) (Seidel et al. 2010, p. 420). Which parts can be standardized? Attempts to manage the whole business process as if it were of one single type will create obvious problems (Lillrank 2003, p. 225). This also might help to provide new perspectives on other BPM-related issues, for example, research on ERP implementation failures (e.g., Karimi et al. 2007). We may need other forms of BPM than standardization and other IT than ERP systems or workflow management systems to support complex processes. Such approaches and tools do not have to target increases in efficiency. For example, context-dependent decision support tools (Rosemann et al. 2008) or mechanisms for enhancing creativity (Seidel 2011) offer BPM instruments that are not related to standardization. To sum up, if the reduction of complexity for certain process parts is not an option because of market conditions and resulting process-inherent characteristics, enhancing standardization effort to leverage advantages of standardization is not a good choice.

Business process complexity is not the only factor that influences business process standardization. Our model is able to explain only 12.1 % (R^2) in the variance of business process standardization. But as the path coefficient exhibits a very significant negative effect, our model shows that business process complexity has a strong impact on standardization. However, this calls for research on other contextual factors that impact the relationship between standardization effort and process standardization (cf. Sect. 2.1) for standard processes that should be standardizable. For example, success of standardization initiatives may depend on

Abstract

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The Impact of Business Process Complexity on Business Process Standardization

An Empirical Study

Today's organizations are struggling with increasing business process complexity and face serious problems when standardizing business processes. A possible strategy seems to be to enhance standardization efforts in order to ensure standardization success. In this paper, we analyze the triangle relationship between standardization effort, business process complexity, and business process standardization. We test the hypotheses that higher business process complexity is related to higher standardization effort and lower business process standardization as well as that higher standardization effort is related to higher business process standardization. We report on the development and testing of a conceptual model that allows to understand the impact of business process complexity on business process standardization and standardization effort. Findings from a survey among 255 business process management experts are used to evaluate our hypotheses. Our results suggest that business process complexity has to be considered as an important driver of standardization effort and constrains business process standardization. Moreover, we show that higher standardization effort cannot compensate for higher business process complexity to ensure business process standardization.

Keywords: Business process standardization, Business process complexity, Standardization effort, Survey, Empirical study, Structural equation modeling

cultural factors such as cultural resistance or shared values supporting the process organization (vom Brocke and Sinnl 2011). This is essential for further BPM research. Process standardization needs to be considered in a variety of business scenarios, most notably process re-design (Davenport 2005; Davenport and Short 1990; Hammer 1990), process outsourcing (Aron et al. 2005; Baldwin et al. 2001; Wüllenweber and Weitzel 2007; Mani et al. 2006; Wüllenweber et al. 2008), process compliance (Krishnan et al. 2005; Mani et al. 2010; Moeller 2008; Sadiq et al. 2007; Syed Abdullah et al. 2010; Weidlich et al. 2010), or post-merger integration (Håkanson 1995; Maire and Collerette 2010; Wijnhoven et al. 2006). Depending on the scenario, we expect other contextual factors to also play important roles.

Davenport (2005) expects the movement towards granular (standardized) and quality-checked business functions or "services" in a true service-oriented paradigm to "lead to commoditization and outsourcing on a massive scale" (p. 101). However, non-routine processes are complex not because of redundancy or simple heterogeneity. Outsourcing might not be feasible for highly complex, non-routine business processes because the processes cannot be standardized. For example, the launch of Boeing's 787 Dreamliner was delayed for three years, which was blamed on the outsourcing of both design and production processes (Kesmodel 2011). So even in traditional manufacturing industries, the use of revolutionary, novel ways may have led to non-routine processes.

Overall, our findings support the importance of business process complexity for business process standardization. BPM experts and process managers will benefit from considering and assessing the complexity of a business process before the start of standardization initiatives, because complexity determines if standardization is at all possible, the level of standardization that is possible, and the effort that is needed. Inefficiencies in terms of wasted resources are then avoidable.

6 Conclusion

Previously, the exact nature of the relationship between business process complexity, business process standardization, and standardization effort was poorly understood within the BPM domain. Factors that drive or inhibit business process standardization remained largely unexplained. The primary goal of this study was to develop and confirm a research model that is able to explain the triangle between the three concepts. We contribute to the body of knowledge on business process standardization with this simple but coherent model and the outlined evaluation. Our research model provides a building block for knowledge on successful and efficient process standardization. We argue that business process complexity is a major factor that process managers need to consider when deciding on processes to be standardized. We are convinced that this is in demand and required by BPM practitioners. Our research helps process managers to make informed decisions and prevent organizations from wasted efforts created by the futile attempt to standardize almost all business processes, even complex non-routines.

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